

14 Alkanes – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)		
alkanes	烷烃	_____	_____	_____
complete combustion	完全燃烧	_____	_____	_____
incomplete combustion	不完全燃烧	_____	_____	_____
carbon monoxide	一氧化碳	_____	_____	_____
ultraviolet light	紫外线	_____	_____	_____
free-radical substitution	自由基取代	_____	_____	_____
initiation	引发	_____	_____	_____
propagation	增长	_____	_____	_____
termination	终止	_____	_____	_____
polarity	极性	_____	_____	_____

Recall

At IGCSE you learned that **alkanes** 烷烃 are saturated hydrocarbons that **burn** as fuels. Now we look at their combustion and their one important reaction with halogens.

- Alkanes have only single bonds (general formula C_nH_{2n+2}).
- They are fairly **unreactive** because their bonds are strong and non-polar.

Nothing here is harder than IGCSE — it just adds a mechanism.

New ideas

Read these first, then do the Practice.

■ 1 Combustion

- complete combustion** 完全燃烧 (plenty of oxygen) → carbon dioxide + water.
- incomplete combustion** 不完全燃烧 (too little oxygen) → water + toxic **carbon monoxide** 一氧化碳 (CO) + soot.

complete: $\text{alkane} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$

incomplete: $\text{alkane} + \text{less O}_2 \rightarrow \text{CO} + \text{soot} + \text{H}_2\text{O}$

■ 2 Free-radical substitution

Alkanes react with chlorine (or bromine) in **ultraviolet light** 紫外线 by **free-radical substitution** 自由基取代, in three steps:

- initiation** 引发 — UV splits the halogen into **radicals**: $\text{Cl}_2 \rightarrow 2 \text{Cl}\cdot$
- propagation** 增长 — radicals react and make new radicals: $\text{Cl}\cdot + \text{CH}_4 \rightarrow \text{CH}_3\cdot + \text{HCl}$, then $\text{CH}_3\cdot + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{Cl}\cdot$
- termination** 终止 — two radicals join, ending the chain.

initiation: $\text{Cl}_2 \rightarrow 2 \text{Cl}\cdot$

propagation: $\text{Cl}\cdot + \text{CH}_4 \rightarrow \text{CH}_3\cdot + \text{HCl}$
 $\text{CH}_3\cdot + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{Cl}\cdot$

termination: $\text{Cl}\cdot + \text{CH}_3\cdot \rightarrow \text{CH}_3\text{Cl}$

■ 3 Why alkanes are unreactive

Their C–H and C–C bonds are strong and have little **polarity** 极性, so there is no charge to attract an attacking species.

Watch out: free-radical substitution needs UV light and gives a *mixture* of products (mono-, di-, tri-substituted). The dot in $\text{Cl}\cdot$ marks an unpaired electron — a radical, not an ion.

Practice

Try these in order.

14.1 Give the general formula of the alkanes. [1]

14.2 Name the products of (a) complete, (b) incomplete combustion of an alkane. [2]

14.3 Why is carbon monoxide dangerous? (one reason) [1]

14.4 Name the three steps of free-radical substitution, in order. [3]

14.5 Write the initiation step for the reaction of chlorine in UV light. [1]

14.6 Explain why alkanes are unreactive towards polar reagents. [2]

14.7 Challenge. When methane reacts with chlorine in UV light, the product is a mixture, not just chloromethane. Explain why. [2]
